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“THE ENGINEER IN NAVAL WARFARE.”

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U. S. N.

I.

MY attention has been called to a number of papers, which, under the above general title, were published in the May number of the NORTH AMERICAN REVIEW.

These articles were written with a purpose. It is manifestly their object to present certain opinions for acceptance, and to incline the public mind to a belief in the desirability of certain changes. They proclaim that engineering is now the leading science, and the care and management of steam machinery the leading art, of naval warfare; that seamen are simply a left-over product of the age of sails, who embarrass naval efficiency, but whom no one has yet devised means to get rid of, and that the

engineer is the "great factor in modern warfare" and must be recognized and honored as such.

These views, if presented only to military men, would need no refutation. They are essentially incorrect, and they are opposed to the principles, practice, and experience of all the navies of the world. But presented to the general reading public—a public for the most part not informed in naval affairs—they are dangerous, so far as their fallacies might gain headway and influence, to the efficiency of the naval service.

I do not take part in the so-called "Line and Staff" controversies of the service, nor adopt the partisan views which sometimes enter into the discussion of measures advocated by one portion of the officers of the navy, and opposed by those of other branches. Having had forty-six years of active service, having reached the highest rank in the navy, and looking forward to retirement within a year, I have no object in contributing to this discussion other than to maintain the efficiency of the navy. With whatever authority the service and experience of a lifetime in our own navy give me—a service varying from that of midshipman in charge of a boat to that of admiral in command of a fleet; an experience including the War of the Rebellion, aided by contact with foreign navies, and improved by the study of foreign naval systems—I shall endeavor to show what the conditions of naval efficiency are, and to what extent and with what uniformity those conditions obtain throughout the navies of the world.

A navy exists for war alone. If peace between nations were definitely assured the navies of the world would be disbanded, their vessels so far as adaptable would be converted to commercial uses, their formidable weapons would be placed in museums, their sailors would embark in other pursuits.

The cost of constructing a modern navy is enormous. A battle-ship costs from three to five millions; a heavy armed cruiser two millions, or more; a gunboat several hundred thousand. Even a torpedo boat—a mosquito of the fleet—costs in the neighborhood of a hundred thousand dollars.

The maintenance of these floating fortresses—the cost of coal and stores, the pay and provisioning of men, the support of dockyards, depots, and hospitals—forms no inconsiderable part of a nation's burdens. And all this expenditure would

be without excuse were it not that a powerful navy is not only a protection to a country in the event of war, but operates to a very considerable degree as an insurance against war, since nations, like individuals, hesitate to attack a powerful and prepared enemy.

War, then, being the sole object of a navy's existence, its organization and its administration should be controlled entirely by the demands of efficiency when engaged in war, and the number, rank, and duty of officers should be determined by these demands alone. Two conditions of a navy, one for peace and one for war, are inadmissible. A navy may be upon a "peace establishment," when there will be fewer ships in commission, and their crews or complements will be reduced; but the framework for immediate expansion must be maintained intact. The organization must be such that the navy can be rapidly "mobilized," to use a comprehensive military term, without any shock or confusion.

It follows, therefore, that in time of peace the organization, discipline, habits, and spirit of naval life should be such as to meet the exigencies of war. War will unavoidably bring new strains, privations, and responsibilities; but the minor details, the routine, methods, and habitual relations should continue to run in the same channels.

A navy is essentially a military organization in time of war; and therefore it must be essentially a military organization in time of peace. That is, military ideas must be the controlling ideas, the military element must be the predominant element, and the military men who train the crews in warlike exercises, and who in battle will employ and direct all the weapons of offense and defense, must exercise authority and command.

The same conditions obtain in all the navies of the world, and the same principles are everywhere accepted. Those which determine the efficiency of the navy of a republic determine also the efficiency of the navy of a constitutional monarchy, or of that of an absolute monarchy; of the American navy, of the British navy, or of that of Russia. The political organizations of states differ, but the organization of their armed forces is fundamentally the same. Illustrations may therefore be drawn from foreign services with every assurance of their fitness, and precedents may be quoted with confidence. And when the experience of

our own service is sustained by that of every other modern navy, the conclusions derived therefrom are entitled to the weight of established facts.

The naval engineers maintain that, since steam is now the sole motive power of men-of-war, and is, in addition so largely employed afloat for minor purposes, they should be considered of much more importance, and should be more independent and have more place and authority. In other words, they claim that steam has revolutionized navies, and that the engineer has practically superseded the seaman. The line officers of the navy—the military branch—the officers who have in our own navy as in all other navies, from the time of their origin to the present time, commanded ships and fleets, conducted expeditions, fought battles, and made history, are the seamen or “sailors” referred to in this claim. Drake, Raleigh, Hawke, St. Vincent, De Ruyter, Nelson, Decatur, Perry, Farragut, and Porter, were among the predecessors of the “sailors” whose day is said to have passed, were brilliant ornaments of that profession now said to be abridged by steam.

It is a very narrow and limited mind which sees in a great art one only of its applications. Seamanship has not passed and will not pass. As long as ships float upon the sea there will be sailors in command. Whether as peaceful traders they pursue the highways of ocean commerce, or as armed vessels seek the military control which protects those highways, seamanship will be the art by means of which they are conducted upon their voyages, through which they are made most effective. It is the habit and the knowledge of the sea and of the ship in which one sails. It existed in the galley period. It was not created by sails and it has not been destroyed by steam. It is neither a lost art nor a decaying art, but it is an art of changing application, and its demands now are as great as they ever were. The seaman of any age must understand all the forces with which he has to deal, and in the present day must understand steam. He need not be an expert, practical machinist, but he must know the limitations of steam machinery, and the laws of its care and use.

Naval line officers generally are fully up to the demands of modern seamanship. The line officers of the United States navy are especially well qualified in this respect. They are well grounded at Annapolis in mathematics and natural science, and

in the application of both to machinery ; and the value of their training has been shown by the important part which they have taken in the design and construction of our new ships. The fields of ordnance and torpedo engineering, of electric lighting and ventilation, have been occupied almost exclusively by line officers. Some of them are not only accomplished engineers, but practical machinists. They have fulfilled all the demands of modern seamanship, and have gone far beyond them.

The seaman employs and directs all the forces of the ship which he commands. He employed the rowers of the galley period, the sails of a later age, and he employs the steam of to-day. The engineer manages the engines of a ship ; but he manages them at the direction of the seaman on deck, who orders them to be slowed, stopped, backed or run ahead at his own sole discretion and responsibility. Marine engineering has reached an extraordinary development in the transatlantic greyhounds of the present day. Their principal quality is great and sustained speed, but the engineer of the " St. Paul " is as absolutely under the control of the seaman who directs the ship as is the mechanic who runs the engines of a tugboat for two dollars a day. The engineer of any man-of-war from a torpedo boat to a battle-ship is in the same position. It is his business to keep his machinery in good order and to run it as directed. Its employment is entirely in the seaman's hands.

And this is not solely a question of the special fitness of the seaman. It is an inevitable feature of the situation. The engineer is below, where he can see nothing but his engines. If he abandoned his engines and came on deck he would cease to be the engineer.

I have spoken of seamen in general. Seamanship, however, is only one of the necessary qualifications of a naval officer. His other acquirements include all branches of the art of war—discipline, organization, strategy, tactics, and the knowledge of the weapons and resources of war. This comprises in itself a profession whose demands have rapidly multiplied during the last generation.

The development of steam has been great ; but the development of weapons and defense has proceeded by leaps and bounds. No discoveries or improvements in machinery have caused among engineers such a readjustment of accepted opinions as line officers

have been obliged to make since confronted with high powered guns, Harveyized armor, smokeless powder, and high explosives. Constant study, constant experiment, and unwearied effort have been required to adapt the rapidly changing means of naval warfare to their effective use.

This military training and military knowledge are of supreme importance to the purposes of a navy; and the men who make it their profession are in fact as in name the "line" of that organization. In the business of warfare the men who direct the operations of war and handle the weapons of war are those upon whom success in war depends. The duties of those who do not take a distinctly military part, while necessary and important, are adjunct and essentially subordinate.

The man who takes no initiative, determines no issues, however intelligent and trustworthy, plays a subordinate part; and such a man is the naval engineer in battle.

"The value of a ship is no greater than the value of the man who commands her," is practically an axiom among naval men; and this means that the effective employment of the ship is wholly dependent upon the qualities of her captain. This high responsibility falls upon line officers and upon them only. It is true that only one among the line officers of a ship carries that responsibility at any one time, but in the event of his death or disability the next in rank succeeds to the command. A lieutenant in a turret, half blinded by powder smoke, wholly intent upon the rapid service of his guns, may be called away by the information that all his superiors have fallen, and that upon him depends the direction of the ship and the issue of the fight. No such duty does devolve or can devolve upon an engineer. His duty remains the same, and remains subordinate throughout all the phases of the battle.

His position in a naval organization is fixed and limited by these conditions. They are the same in all navies, and the military relations which flow from them are the same. In the British Navy, the Queen's Regulations place the engineers in the "Civil Branch," and specify in clear and unmistakable language the authority over them of the military branch. In continental navies, the sea-going engineers, called with a proper distinction of language "mechanicians," are simply artisans, and are nearly all promoted from the ranks after an experience

which has rendered them practically expert in the management of marine steam machinery. They are trained as our locomotive engineers are trained.

The engineers in the United States Navy are already better off than in foreign services. They have more pay, more rank, and more official consideration than in other navies; but the difference is one of degree and not one of kind. Their duty determines their position, and it must remain essentially the same.

And in considering this position it must not be forgotten that the care and management of steam machinery afloat is not "engineering." Engineering is a liberal and progressive profession, and finds its exercise in design and construction. When the engines are built and placed in a ship they are turned over to the mechanician or engine driver, a trained artisan skilled in practical work, but not necessarily or generally a man of liberal education. The former is a profession; the latter is a trade.

The engineer, as an engineer, does not follow the ship away from the dock-yard. If he takes charge of her engines afloat, he ceases to practise his profession of engineering, and becomes an engine driver. It is a defect in our own naval organization that the same class of men perform the two classes of duties; that engineers, capable of good work in their profession, are sent to sea to do as a matter of habit and routine the work of artisans. There should be a division of duties, and engineering should be placed in its proper position, as it is in continental navies, where men of high professional capacity do little or no sea service, and in fact constitute a different branch. The men who go to sea in charge of engines should be mainly practical men—skilled machinists—who would not rise above warrant rank, the class of men who run the engines of the merchant service, even of the great passenger steamers, and who are found in the engine-rooms of the British, French, Italian, and German navies.

Such a change would not only be good administration in itself, but would relieve the navy from the discontent now felt by highly educated young men who go to sea in the position of engineer of the watch.

This position, I repeat in conclusion, depends upon its duties, and its occupant cannot rise above them, no matter what his intelligence, education, or professional value. At sea he is an

engine driver with no demands and no duties beyond those imposed upon the practical mechanician in the same place.

J. E. WALKER.

II.

ALL questions that arise among men have a tendency to become involved, in the course of discussion, with a cloud of details, sometimes germane to the matter in hand, sometimes entirely foreign to it, but conducing to withdraw attention from the central facts, usually few and simple, which are really decisive of the matter in hand.

A navy is, first and last, a military body of which the distinguishing characteristic is extreme mobility. This characteristic derives, primarily, from the element in which navies act—the water—which lends itself with peculiar facility to the purposes of movement. The element remaining constant, this statement is true of all ages, the particular motive force in use at any era being simply incidental; whether it be the wind, steam, electricity—which the future may bring—or men's muscles, in the handling of oars, which, in the case of military navies, was the historical antecedent of wind and steam alike. Mobility is the permanent characteristic, the end or object in view; the power which gives motion, the means or method of obtaining motion, is transient—of one sort to-day, of another to-morrow. Results, not methods, are the considerations which concern practical men of action. It is the mobility, and not how the mobility at a particular period is got, that constitutes the peculiar value of navies.

Mobility, the power of useful movement, resolves into two constituents. There is the motive force, the power to move at all, whatever be the source from which it springs—wind, steam, electricity, or animal force, as with oars, and vehicles drawn by horses; and there is the directive power, which, and which alone, insures that the motion, instead of being aimless, or even harmful, shall be useful, intelligent in its action, and subject to necessary changes, such as turning or stopping to avoid injury. A steamer under full power abandoned by the helmsman, a carriage in mid-career drawn by spirited horses and abandoned by the driver, are illustrations of motive power abandoned by directive power.

These two components of mobility are logically distinct. They can be separated in idea; and although they must be combined,

unified, in any moving object, unless destruction is to ensue, yet it is possible, and may be necessary, to separate them for practical consideration. Take for instance the unit man, regarded as a moving object. The power of his legs is one thing, the sight of his eyes is another; one is the motive force, the other the directive, both administered by the same person. Yet in that same person they are divided, separable in thought and act, as any man will find who with undiminished bodily strength attempts to walk in dangerous places of a dark night. His motive efficiency has been divided; the power of motion remains, the directive power is withdrawn. He is the illustration of the steamer abandoned by the helmsman—or, rather, by him who sums up all the directive forces, the man in charge of the deck.

Historically it has happened, for a period comparatively brief, as the world's life goes, that in the unit ship the control of the two elements of mobility could be combined in the same man. The wind, as the source of power, compelled the means whereby it was utilized, the spars and sails, to be exterior to the body of the ship, and there they could be embraced under the control of the same eye, which scanned at once the direction the ship was taking, and the signs of the weather, which dictated the management of the motive engine. It was not so with the galley, where the position of the toiling oarsmen, their backs turned to the direction the ship was taking, symbolized vividly the sphere to which the motive power must be relegated, when the immediate management of it was forced to leave the deck. That period arrived necessarily with the steam engine. Constructional considerations alone, the distribution of weights, would have enforced it; the exigencies of military navies make it yet more necessary to sink to the lowest depths of the ship that blind and dumb engine which can move, and can do nothing more. For its security, it, which cannot protect itself, must be protected by submersion, and by accumulation of artificial protection in the shape of armor. The engineer and the engines must be made safe to the utmost of human precautions, must be withdrawn to the utmost from exposure to military hazard, because they cannot defend themselves, and because power to move is essential to the efficiency of a ship of war. For this reason, protection, in the strict sense of the word, must be withdrawn for the most part from the combatant force, because guns, in the main, can and

should defend themselves. Offence is the best defence, and in the due study of that simple principle will be found the true solution of the disposition of armor between the batteries and the engines. Protection, except for the directing force—the commanding officer and the helm—will have to be withdrawn in large part from above.

The quarrel between the members of the body is an old story. No nation, no community probably, exists without parties; they are perhaps the necessity, certainly a concomitant, of healthy life. The reconciliation in any body can only be reached by a candid recognition of the proper functions of each member. The head may not say to the feet, “I have no need of you”; but for all that we don’t undertake to see with our feet. No combination of persons can act effectually, unless some provision is made whereby unity of action can be insured; and in matters of great moment, even in civil life, executive action can only be strong by being unified in one head. All attempts at a many-headed executive, meant as a provision against tyranny, have resulted in discord and feebleness. Two cannot walk together, unless they be agreed; and if they disagree, there can be no unity, unless it be clearly understood that in such case one commands and the other obeys.

In the unit ship we have side by side the two elements, the motive force and the directive force, which, taken together, constitute the efficiency of the ship as ship. When they fail to agree—and that dispute, seemingly radical, does arise is notorious—upon what principle shall unity be preserved? Shall the eyes, or shall the feet, dictate what shall be the direction of the moving body?

The argument so far has been confined to the consideration of the ship in general, without special reference to the naval ship as a military organization. Before touching upon that, and so leaving the first part of the subject, it is desirable to meet the statement often advanced, that the introduction of steam has reduced the functions and the responsibility of the officer in charge of the deck, be he the captain or his youngest lieutenant. The statement is absolutely erroneous. A particular kind of accidents has been eliminated, skin-deep injuries of splitting sails and carrying away spars, but beyond that steam has not diminished, but rather increased, the danger and the scope of accidents

at sea. Steam has facilitated movement, and movement quickened has increased as well as diminished danger. Seamen are by it not only tempted, but compelled, to incur new risks—to curtail the margin of safety—a process which entails the necessity of greater skill, greater readiness, and precision of handling. No safer vessel at this moment floats the sea, as against the dangers of the sea, than the sailing ship-of-war of recent date, excluding the smallest classes. From the sloop-of-war to the ship-of-the-line, with average care, they were safe in all kinds of weather, while the danger of fatal collision was for them practically non-existent. The great danger of going to sea now is collision, whether with other ships or with the shore, and—whatever constructors may accomplish in the way of minimizing consequences—for the avoidance of collision the man in the engine-room has no more to do, beyond obeying signals from the deck, than a man ashore. All depends upon the watchfulness, the intelligence, and the presence of mind of the man on deck—the repository for the moment of the directive force. This consideration, important in all ships, is tenfold so for ships of war, for all great naval influence depends upon the power of huge ships of war to move in close order and concerted action, the changes incident to which carry a constant and inevitable risk of collision. Safety in such movements depends almost wholly on the man on deck, who sees and orders, and to a wholly inferior degree upon the one who merely obeys signals, the reasons for which he cannot know.

Turning now from the merely nautical side of the question, we shall touch the military side of a ship-of-war very briefly because there is a superficial admission that the efficiency of every military unit—army, regiment, fleet, ship-of-war—however composite in its general make-up, depends upon command being centred in one man, who is responsible to none below him, and who must receive unquestioning obedience. The admission, I say, is superficial, by which I do not mean that it is feigned, but that it does not fully understand, for it sees, recognizes, and admits unity, not in the *power* of command which is represented in one individual, but only in the *person* of him who is the permanent representative. It recognizes the captain, but resents the executive officer and the officer of the watch. The spirit, however, is one. However honest in its denials, the objection lies equally against the

captain's authority, and historically has spoken against it. The musty files of our own navy contain the record of disputes as to how far a commanding officer could control one of the subordinate bodies constituting his command, and in the British Navy, at the same period, the question of the captain's authority over a class of soldiers on board for the purposes of the ship was brought to a direct issue—the necessity for unity eliciting the strenuous support of Nelson and St. Vincent, the two greatest admirals Great Britain has had. The same repugnance to the demands of military organization appears again in the papers in the NORTH AMERICAN REVIEW of May last, which have necessitated the present articles. “The naval engineer has urged that military routine, which may be necessary for a marine guard, cannot be applied to the management of the fire-room force.”* “There should be extended to the navy the system of the merchant marine, which gives engineers immunity from the interference of mates on deck,”†—*i. e.*, from the officer of the watch.

The difficulty proceeds from a confusion of thought. The unity of a military organization lies not in the *person* of him who is at its head, but in the *power* which he possesses, and of which he is in general the representative. Were it otherwise, detached service would be impossible; power would be inseparable from the person, and where he could not be, power would lapse and anarchy supervene. The power of the captain is not in his own person, any more than that of a lieutenant is in his. True the captain's authority carries with it a certain position and functions, which he cannot divest himself of nor transfer to another; but his power, and that of the lieutenants in their sphere, and of the engineers in theirs, are alike derived, as is the power of the President of the United States himself. It is the kind of the power, and not the receptacle in which it reposes, which is the essential factor. In the state the civil power is supreme; within a military organization the military power is supreme. In the special military organization known as the navy, the directive power and the military power must, from the nature of the case as set forth, go together. The ship must be guided and she must be fought. They who fight must guide; there rests power. Unity also demands that organization and administration, the essential precedents of good fighting, remain in the same hands.

* NORTH AMERICAN REVIEW, May, 1896, p. 513. † *Ibid.*, p. 545.

In any living organization the supreme power never dies. The King never dies ; and against the possibility of the President dying we have made an elaborate provision, which sufficiently speaks for the danger it seeks to avoid. But in the slow moving action of the huge organisms that we call nations and governments, there is time enough for Kings and Presidents to sleep, to be off guard ; whereas, in the rapid movements of ships, and the frequent sudden vicissitude of sea-life, the captain—the captain's *power*—cannot sleep ; it is plain to say his *person* must. No more than the proverbial switch-tender can he, as a habit, be on duty twenty hours out of the twenty-four. Hence arises the necessity for the watch officer, who is in charge of the deck, and vested while so with all the captain's power for the conduct of that which goes on on deck, or pertains to the direction. He holds this control not because he is the captain or lieutenant, by grade and title, but because of the office he is then filling. Is this considered an extravagant claim—unlimited ? It is not, because all military power, however absolute in its essence and claim to obedience, is limited strictly by law, responsibility to which holds in check every person invested with it. From censure to dismissal from the service is the range of penalty, for any military officer who oversteps the limits which law has laid down to control his use of a power which is otherwise absolute.

And as it is on deck, so it is in the engine-room. The man in charge there, himself in his sphere, exercises a control as absolute as the captain and the officer of the watch—like them absolute, like them limited. But there are two on duty at the same time—the deck officer and the engine officer, the directive and the motive forces. The unity of result demands that they be not independent. One must be the superior, and it must be the one who has charge of the directive force, as that which is the more essential to the safety and government of the vessel ; not because the one man is superior to the other man, but because the one power is more important than the other.

From the same confusion of thought between the person and the power arises the claim—preposterous to line officers—that the titles of the line are in some way essential to the authority and dignity of engineer officers. A captain's authority rests upon the power necessary to the commander of a ship, whatever he be called. The deck officer's rests not upon the title he bears,

lieutenant or what-not, but upon the duty laid upon his shoulders and the power needed for its discharge. Similarly, that of the engineer is conditioned upon the duties he has to fulfil. To call him a lieutenant does not help matters in the least, for the lieutenant's authority does not depend upon his title. If, however, the titles, which in the process of years have come to designate certain duties of the directive officers, are sought for those who manipulate the motive forces on the ground of the latter's dignity, the reply is simple. The republican idea knows nothing of titles, except as convenient names which designate duties. It would be quite as fitting to call a senator of the United States a duke or an earl for the sake of his dignity, as to call an engineer a lieutenant or a captain for the sake of his. An engineer is called an engineer because he has to do with engines ; to call him a lieutenant simply obscures his functions. The little glamour that in some eyes seems to hang round the mere titles, admiral, captain, lieutenant, etc., is due simply to the fact that they have a somewhat long historical derivation—something of the venerableness of years. The engine is a new comer : it has brought its own nomenclature, including that of those who run it.

A. T. MAHAN.

III.

HAVING commanded three of our modern vessels, I feel that I may contribute my mite towards a fair understanding of the question brought prominently to the public notice by certain articles published in the May number of the *NORTH AMERICAN REVIEW*.

An engineer officer of the highest rank gives his views with great freedom as to the defects in the military organization of navies, especially of our own, and the changes which must take place lest they be found wanting in the hour of trial. This able man, gifted as he certainly is, who ought to know thoroughly any subject that he writes about, has never served one day on board a modern vessel of war ; yet he tells us that the navies of the world may be put right by simply increasing the number of engineers, and giving them the titles of officers of whose duties they have neither part nor knowledge ; and he asserts that this is an imperative reform—the one thing necessary to efficiency.

His demands are seconded by several professors engaged in teaching mechanical engineering in schools and colleges. They agree with Engineer-in-Chief Melville as to the necessity of his remedy, but they find also another one desirable to repair the evils, which, as they can plainly see from their desks, are demoralizing the navy. Their remedy is government aid to the colleges which they represent, and government appointments to their graduates, who will, they assume, have great merit as marine engineers without ever having seen the inside of a ship's engine-room, and a high sense of military discipline without ever having felt its restrictions or exercised its responsibilities.

The three modern ships which I have commanded at different times—the “Yorktown,” “New York,” and “Indiana”—have received uniform commendation. The records made by the first two demonstrated their efficiency in all departments. This was true of them in the highest sense, and it will be equally true of the “Indiana,” our first great battle-ship, when reasonable time and experience shall have familiarized officers and men with her qualities and capacities, and have corrected the mistakes made by people who do not go to sea.

The “Yorktown” steamed from New York to San Francisco, stopping for some time at Valparaiso on important service. Beyond the constant sea-sickness of the Chief Engineer our difficulties arose without exception, from either the ignorance or the carelessness of the shore engineers. Boilers were not protected by zincs, their tubes were pitted, the distillers were incapable of doing the work for which they were designed; yet we did, on board ship, make things go, and the ship was always ready, efficient, and happy. The feeling between line and engineers was one of respect and regard. The vessel was afterwards flagship of the Behring Sea Patrol Fleet, and did her work to the entire satisfaction of everyone, so far as I know, from President Harrison down.

My second command, the “New York,” has not had, in my opinion, her superior in any service for efficiency. In the beginning her distilling plant was inadequate, her condenser tubes were wrong, and other small neglects of the shore engineers gave us more or less trouble; but we overcame them all without giving line titles to the engineer officers, or changing their relation to the military organization. They settled down to their work under their able

chief, were happy, contented, and efficient. Her full-speed trials showed clearly the efficient condition of her engine department, and a further test was her long cruise as Admiral Meade's flagship, when accurate handling of engines was uniformly demanded. Her run from New York to Kiel, touching at Southampton and Copenhagen, was made at high speed, and without once stopping the engines to repair. When inspected at half-past one o'clock in the morning without previous notice by the German Emperor, her condition received unqualified praise from him and the able officers of his staff. Naval representatives of all nations at the great Kiel review, looking keenly for defects, were able only to admire in every particular. Later, in England she was visited by representatives of the Admiralty and other officers of high rank and much experience. All without exception commended her heartily, remarking only upon what seemed to them the large number of commissioned engineers in her complement. This military estimate by military men of a man-of-war's efficiency may with confidence be set against the opinions of engineers, either naval or civil, who "stick to their desks and never go to sea."

The battleship "Indiana," my present command, promises to equal the others in efficiency when minor defects of construction and equipment have been overcome. These are to be expected in a pioneer vessel of a new type, and the larger and more powerful the vessel—*i. e.*, the greater the variety and complications of weapons and machinery—the more numerous they will be. They are all defects in mechanical design and execution, and in remedying them the line officers under my command exhibit a resource and facility fully equal to that of the engineers. The joint efforts of all are rapidly making the "Indiana" the peer of any battleship afloat.

It was necessary to relieve her chief engineer, one of the "contemporaries" referred to by Engineer-in-Chief Melville, in the first half-year of her commission, his administration not proving satisfactory. Nor was this due to the "trinity of men claiming to be vested with supreme authority." Bent valve stems, engines unexpectedly starting in dry dock, hot bearings, and a general want of efficiency were caused, not by the "trinity," but by the lack of practical knowledge of modern steam machinery. Educated on a maximum of 40 revolutions a minute, 120 was more than he could grasp.

Natural reasons for natural phenomena always exist. When this chief engineer and one of his assistants assured me that there was no reason for the "Indiana's" engine starting off in dry dock, I felt that it was time to insist upon a change. Neither line titles nor government aid to engineering schools will better this condition ; but there is a remedy and one easily applied.

The "trinity," so bitterly referred to, consists of the captain, the executive officer, and the officer of the deck. The captain's authority is not as yet questioned, but the authority which the other two employ, always as delegates or representatives of the captain, is deeply resented. It is, if one believes them, the "hoodoo" of the engineers. Yet this organization is the same in all navies, and is the fruit of all naval experience. It represents discipline and power. It is the fad of to-day in some quarters to pull both down ; but it is not a creditable effort for one of the branches of the naval service.

Discipline and executive ability on the part of those in charge are the prime factors of efficiency. Discipline in its highest sense does not exist without willing, hearty, intelligent obedience of orders. A captain can always enforce obedience, but the more force employed, the less real the discipline. I find that the discipline of the engineer's force is not as good as that of the combatant force, and that this is due to the difference in attitude and spirit towards the military organization of the ship. I have the same power over both forces, and have the sole authority to administer rewards and punishments ; and if I had the same loyal support from engineer officers that I have from those of the line, the discipline throughout the entire force would speedily become the same.

The engineer officer does not give the same careful attention to his men. He has not, as a rule, the same executive ability as the line officer. He does not lay out work and apportion responsibility so well. His personal sense of discipline is not, in many cases, all that could be desired. The kind of obedience that leads to the greatest efficiency is not always found, and there is a reason for this.

Imagine a naval service in which all the officers of one branch are seeking to obtain the titles of the officers of another and the strictly military branch ; to drop the titles which they hold, and which are descriptive of their duties, and assume other titles

which describe the duties of another class of officers. Imagine further that these same officers are also seeking a removal of the demands and restrictions of naval discipline as applied to themselves. Let these officers use every effort to influence public opinion and Congressional action in their favor and against the officers of the military branch ; enlist the assistance of societies and unions of men of the same profession as their own in civil life ; send circulars to boards of trade ; suggest that apparatus, machinery, and professors shall be supplied to colleges at government expense ; propose that a certain number of the graduates of these colleges shall receive each year a substantial bounty from the government ; and direct all this influence to an attack upon the existing organization of the service to which they belong. Would not a condition of unrest and discontent among them be expected ? Would it be surprising to find discipline impaired, its impulses less healthy, its responses more feeble ?

Such are the efforts of the naval engineers to-day, and the propaganda finds its legitimate result among engineers afloat. They are encouraged by their seniors ashore to think that Congress will embody their views in legislation. These views are vague. They have never definitely formulated them nor explained them. They want "authority to command and discipline their men." They already have more than they exercise. The principal interference with the engineer's force is rendered necessary to carry out "command and discipline" vested by regulation in their hands, but neglected or evaded.

Their social position, like that of the line and other branches, is based on a commission in the United States navy, and beyond that is precisely what each individual makes for himself. They enter the navy for certain duties, and they bear titles which indicate those duties. They may consider line titles as of more prestige and more desirable ; but the organization of a great service cannot be overturned to suit the vanity of individuals.

Engineer-in-Chief Melville's word picture of the fireman in time of action is very striking, and will, I think, prove to be absolutely true. The fireman will face the red-hot furnace, will perspire freely, and wear little clothing, while he shovels in the coal which gives out the power to drive the great machine of destruction. The Chief will stand by the throttle ready to "hold her nozzle agin the bank," and his assistants will be at their sta-

tions to assist him and die for their country if necessary. They will do all this because it is their duty to do it, because they are trained to do it, and are paid to do it. Each at his station, and all behind eighteen inches of side armor and below a protective deck, they will wait for something to happen on the decks above them. If a shot should by any chance get through the armor and enter the boiler, would a line title for the chief engineer help matters? Surely no. He is doing an engineer's work. It is cut out for him and for his men, and they will, no doubt, perform it faithfully until death or the end of the fight gives them rest. He stands ready to receive and obey the captain's signal, and must obey it implicitly, blindly. The discretion is not his, nor the decision, but simply the execution.

What of the other hundreds on board? Where are they, and how do their billets compare with that of the man before the roaring furnace? What of the man behind the roaring gun? And what of the men in the thirty-six magazines? I have been led to think very seriously of these things during the past six months, and it seems to me that the man below and behind armor will be very fortunate in the supreme hour of a battleship's existence. There will be that above which tries men's nerve as well as their endurance. Carnage, the wreck of superstructure, splintered boats, fallen funnels, dismounted guns, will test the temper and quality of the "man behind the gun" and of the officer who commands him. The captain in the conning tower (perhaps not the one that took the ship into action, but a lieutenant or possibly an ensign) will have before his eyes this scene of destruction, and before his mind the picture of his vast responsibility. Throughout the action it is his province to decide upon the employment of each weapon, to determine when his 12,000 tons shall be sent crashing into the side of his enemy. Even at the moment of ramming, when the engines are doing all the work, the chief engineer has neither initiative nor discretion. He obeys a signal then as at all other times. Is there, then, any comparison between the duties of a chief engineer and those of a captain? between the position of a fireman and that of a sailor? Is this an "engineer's ship"?

The highly educated engineer, the man who is capable of designing and constructing machinery, is too much of a luxury for ship's rough work. What we need for engine-room watch stand-

ing is a class of practical men trained in machine shops and engine-rooms—such men as might be recruited from the various ship yards where they have made and put together the engines and boilers over which they would stand watch; and from the merchant service, where they have learned to drive machinery to make dollars and cents for their owners.

If the educated engineers are to stand watch, there are too few of them. If they are to supervise only, one in a ship, and machinists are to stand watch, there are too many of them. In my opinion their number should be reduced, and we should take into the service a corps of warranted machinists. The permanent position and good pay would attract the best men of a most desirable and efficient class.

R. D. EVANS.

IV.

Two ideas are assiduously advanced by the naval engineers: first, that they are the sole inheritors afloat of the genius of Watt and his fellow pioneers in modern science and mechanism, the sole representatives in the navy of the progress and development of this age of steel and steam; second, that “engineering” and “engine-driving” are one and the same thing, demand the same education and accomplishment, and merit the same recognition and reward.

Naval conditions have wholly changed within the experience of men still in active service. Steam, forty years ago an auxiliary, has now become the sole motive power, sails have been wholly discarded, and vessels of war are filled with machinery to steer, to hoist, to handle guns, to obtain efficient ventilation and drainage, all of which is operated directly or indirectly by steam. The domain of mechanics in a modern fleet is a wide one; the value of mechanical knowledge is almost universal.

In this naval renaissance line officers have borne their full share both in design and execution. Carrying from Annapolis a polytechnic training, long anticipating the new departure, they met more than half way the changes demanded by the new order of things, and quickly placed themselves in entire accord with its most advanced requirements. Their stake was greater than that of the engineers, for they command the country’s ships and fleets, and would be held responsible for their operations in war.

Under their sole direction and guidance has been developed the manufacture of steel, urged on by an ascending scale of requirements to the highest results, the manufacture of armor which has led the world, all ordnance and torpedo engineering, electric engineering in its application to ship's lighting, search-lights and motors on shipboard, and the complicated systems of interior communications; and they have shared with the constructors the responsibility for the ventilation of ships. The gun shop at the Washington Navy Yard, which has not its superior, perhaps not its equal, in the world, is entirely their creation. A line officer has invented the range finder, the stadimeter and a variety of electrical appliances with which our vessels are fitted. In the new battle-ships the engineers receive directions by an electric telegraph, and the number of revolutions of their engines is transmitted by an electric indicator, both of which are the inventions of a "sailor" officer.

The engineers have been fully occupied in keeping up with the times in their own especial province.

The crucial experience of modern naval development, as marked from time to time by naval battles, has not altered in any respect the relation of the seaman to the men and forces under his control. Lissa did not differ from Trafalgar, nor the Yalu from Lissa. The actions of the Civil War, whether between sailing vessels, Mississippi steamers or monitors, were all the same in their military character. The seaman has always been in supreme command, and has employed at his own sole discretion every force and factor in his ship. The engineer has never yet become of prime importance; nor does history offer any expectation that he will.

The second point indicated above is the difference between an engineer and an engine-driver. A confusion of ideas in this respect is maintained throughout the articles to which this paper replies. The engineer and engine-driver are made to appear one and the same person, the liberal profession and the trade one and the same occupation.

Engineering is a great profession, liberal and comprehensive. It has directed the industrial development of modern times, and mechanical engineering, as one of its branches, shares its fame. But this high professional work ceases when design and construction are completed. The finished product is then handed over to

another occupation ; to men skilled by daily practice in its employment and care.

An engineer may go to sea in charge of engines, but while so engaged he is an engine-driver. This continually happens in our own navy. Highly educated young men are taken into the service as assistant engineers and are sent to sea to do the duty elsewhere performed by men who are qualified only for engine driving. Month after month, and cruise after cruise, their regular routine duty is work nowhere else given to men of their intellectual and professional position and attainments. Naturally they feel this disparity between the purpose for which they have been prepared and that for which they are employed, and this feeling finds issue in discontent and agitation.

On shore their duties are professional. They fully appreciate this difference. Engineer-in-Chief Melville said himself, not long since, with respect to one of his assistants, who, his term of shore duty having expired, was about to be ordered to sea : "He is worth \$20,000 a year to the government as a designer ; and he is to be sent to a ship to become a mere engine driver."

The functions and positions of engineers and engine drivers (mechanicians) should not be confused. The navy in commission and ready for service—the military marine—has to do only with the second class.

Of these an ample number is needed in a modern fleet. In vessels filled with mechanism there must be a sufficient staff skilled in its care and use. No one of the many machines upon which the efficiency of a ship more or less depends may be allowed to suffer through neglect or ignorance. Upon this point there is no difference of opinion ; and the remaining question is, of what class shall the great body of these mechanicians be composed ? Engineer-in-Chief Melville and his friends insist that they shall be university men fully educated for engineering. Line officers hold that they should be practical artisans, trained in machine shops and engine-rooms, with muscles hardened by actual manual labor, and habituated to the exposure and fatigue incidental to their duties. They maintain that mechanical experience is a better preparation for these duties than college classes and lecture-rooms.

The view of the naval engineers is supported only by their theories and assertions. The contrary view is sustained by the experience and practice of the great navies, and of the merchant

marine. The tendency has been in navies to decrease the number of commissioned engineers and improve their professional acquirement; to increase the number of mechanics and give them the permanent and assured status of warrant rank.

The number of commissioned engineers in the United States navy is already greater per ship and per horse power than in any navy of Europe. The Squire-Wilson bill would make it more than twice as great.

The following table shows the proportion in the several great navies :

	Number of engineers per ship.	Horse power to each engineer.
Great Britain.....	2.15	2,220
France.....	1.88	2,783
Russia.....	1.79	2,834
Italy.....	2.16	2,180
Germany.....	.96	3,920
United States.....	2.70	1,569
United States (proposed by Squire-Wilson bill).	4.21	1,004

Torpedo-boats are not included in the number of ships. Of these, Great Britain has 166, France 234, Russia 173, Italy 179, Germany 145, and the United States 18, including all authorized.

It will be noticed that Germany has less than one commissioned engineer to each vessel of her fleet. The German navy is noted for its active, hardworking, and progressive qualities. It is not hampered by traditions, because it is a young navy and has none. It receives the personal attention of a young, vigorous, and warlike emperor, counting his brother among its superior officers, and the sole criteria of its administration are efficiency and economy. Nor does any nation test so frequently or so stringently by mobilization and manœuvres the actual condition of its military services as does Germany, or apply so relentlessly needed measures of reform.

But with this small body of commissioned engineers is associated in foreign navies a large body of trained and skilled practical mechanics. In continental navies these have existed from the introduction of steam. The following table shows the great change which has taken place in the British navy in this respect, especially in the last few years.

Since 1889 the British navy has been enormously increased. Two great building programmes have authorized 173 ships, many of them of unusual power and size. Its fighting strength

has been doubled, and its administration, training, and methods have been much improved.

ENGINEER OFFICERS AND ARTIFICERS (MECHANICIANS) IN BRITISH NAVY,
1863 TO 1896.

	Engineer officers.	Engine-room artificers.
1863.....	1,418	none
1868.....	1,265	90
1874.....	965	209
1877.....	898	393
1880.....	790	573
1883.....	691	788
1886.....	676	1,124
1888.....	687	1,163
1893.....	741*	1,541
1894.....	782*	1,898
1895.....	831*	2,068
1896.....	845*	2,335

*These numbers include about 70 engineers carried for "other service" and not "available for sea."

To what extent have the commissioned engineers shared in this movement? With an increase in the total *personnel* of 50 per cent., and of the engine-room artificers of 108 per cent., the number of engineers has been increased only 24 per cent. It does not appear that in the British navy the engineer is yet considered "the great factor in naval warfare."

Our engineers cite their great numbers during the war as an argument for increase. On January 1, 1865, they numbered 2,252, but only half were commissioned officers, 1,125 being third assistants with the rank of midshipman, and receiving a pay less than that of warrant officer. Of the 1,127 commissioned, 734 had the lowest rank, the relative rank of ensign. The body of volunteers (1,778 of this 2,252) were practical machinists, taken for the most part from the engine-rooms of merchant craft, and returning at the close of the war to their former occupation.

The importance of having in a fleet a certain number of highly educated engineers of commissioned rank is not denied; but they should serve afloat for the general superintendence and control of the engineers' divisions, and not for the performance of routine and subordinate duty. The educated engineer's breadth of mind, his rank, and the official status which it gives him, better qualify him for administrative direction—for the position of chief engineer—but it does not follow that his subordinates should be men of the same class. The naval experience of the present day, after ample service with mastless ships, sums up about as follows: Torpedo-boats and small craft require no commissioned engineers;

gun vessels and small cruisers require one ; battleships and other heavy vessels two, a chief and an assistant; flagships perhaps three, to provide for chance vacancies. All watch standing should be done by mechanics, brought into the service if possible as boys, trained in shops and engine-rooms, and advanced through the several grades of petty officer to the rank of warrant officer like our boatswains and gunners, with good pay, assured position, and the privileges of retirement.

Such a reorganization of the naval engineers would obviate a feature to which the attention of the country is periodically called by paragraphs in the papers from Maine to California, viz.: their physical breakdown on shipboard, which is constantly advanced as an argument for more rank and greater numbers. Many engineers have broken down ; so have people in other walks of life. It is one of the ills of the flesh. Line officers break down ; but these incidents are not employed in a propaganda.

The trouble lies with the men, not with the conditions of service. Many of the chief engineers of the navy are advanced in life and have led during long intervals between cruises sedentary lives on shore. They are too old—some of them sixty years of age ; they are unfamiliar with the more recent machinery, and they can't stand the strain. The younger men who collapse simply lack the requisite physical strength. Men advanced in years are not fit to go to sea in positions of physical and mental stress. Remove the older engineers from the sea-going list, advance the younger men to the positions of chief engineers of our large ships, put a good class of warranted mechanics into engine-rooms—brawny, vigorous young men, sound in wind and limb—and there will be no more “breaking down.” We hear that the “Indiana,” after a week's cruising at ten knots, sent her chief engineer and one assistant to the hospital. How absurd ! What do the practical men who run Cramp's speed trials think of that ? The “Indiana's” engine-room at ten knots would be a playground to them. What are we to expect in time of war from men who break down during drills ?

The *personnel* of this, as of other branches of the navy, must be adapted to the actual conditions of its service. These are arduous and exhausting ; and given a good practical knowledge of machinery, they demand as a first requisite physical endurance. Good lungs, heart, stomach, and muscular development

are necessary to withstand the heat and confinement, the coal dust, and oil spray in the machinery spaces of a modern man-of-war. Where shall we obtain this class of men? Certainly among those who have made such work their vocation, and who are therein a survival of the fittest, the physically incompetent having been eliminated. Certainly not from college graduates without knowledge or experience of the work, or of shipboard life.

Running through the papers in the May number is a distinct note of opposition to military discipline—of protest against authority—which is worthy of attention. The engineer is commended for “attempting to use industrial methods” in ships of war and for opposing “military routine.” But, while contending against the requirements of discipline and military organization, the naval engineers ask for themselves more rank and purely military titles; and insist that a military status is essential to their efficiency. In brief, we take from their own statements the conflicting opinions that in a military marine the engineers are essentially a military body, and that their status, their rank, and their titles must be made so; and finally that their methods should be “industrial” and that “military routine” should be abolished from the firerooms.

It is fitting that the close to these arguments should be made by a gentleman who finds the position of a naval line officer the same as that of a mate in a merchant vessel, who finds that “sailors” have dealt long enough with naval regulations, and who has decided that Congress shall, upon this point, register the decrees of the Marine Engineers’ Beneficial Association, which organization, after coming into touch with the Naval Engineers, “now realizes the power which it possesses.”

S. A. STAUNTON.